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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE

No. 1072

EFFECT OF BRAKE FORMING ON THE STRENGTH OF 24S-T ALUMINUM-ALLOY SHEET

By George J. Heimerl and Walter Woods

Langley Memorial Aeronautical Laboratory
Langley Field, Va.

Washington
May 1946

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SUMMARY

Tests were made to determine the effect of brake forming on the strength of 24S-T aluminum-alloy sheet that had been formed to an inside bend radius of three times the sheet thickness. The results for both directions of grain of the material showed that the compressive yield stresses were appreciably increased, the tensile yield stresses were moderately increased, the ultimate tensile stresses were only slightly increased, the elongations were considerably reduced, and the shapes of the tensile and compressive stress-strain curves were markedly changed.

INTRODUCTION

Large increases in compressive yield stress in the curved corners of formed Z-sections of 24S-T and 17S-T aluminum-alloy sheet were indicated by the preliminary data given in references 1 and 2, respectively. In these investigations, no information on the tensile strength of formed corners was obtained; in addition, the curved corner specimens included a small amount of flat (unformed) material on the edges. The present investigation was therefore undertaken to determine the effect of brake forming on the tensile as well as the compressive strengths of 24S-T aluminum-alloy sheet; corner specimens that included only curved material were used.

SPECIMENS AND METHOD OF TESTING

Curved corner tension and compression specimens, the dimensions of which are shown in figure 1, were cut from the corners of Z-sections (see fig. 2) that had been brake-formed of 0.125-inch-thick 24S-T aluminum-alloy sheet to an inside bend radius of three times the sheet thickness (r = 3t).

Reference tension and compression specimens were taken from the flat web and flanges of these Z-sections. The dimensions of the flat tension specimens conformed to the A.S.T.M. Standards for sheet material (reference 3); the flat compression specimens had the same over-all size as the curved corner compression specimen shown in figure 1.

For the tension tests of the curved corner specimens, special inserts were required between the Templin self-alining grips and the specimens in order to maintain the original cross-sectional curvature and also to make the centroidal axis of the specimen coincide with the center of the grips when the load was applied.

For the compression tests, a Montgomery-Templin type of compression fixture (see reference 4 for the technique in using this fixture) was used for both the flat and the curved corner specimens. The supporting plates for the curved corner specimens, together with the fixture, are shown in figure 3.

Tuckerman optical strain gages were used to measure the strain for both the tension and the compression tests.

RESULTS AND CONCLUSIONS

The results of this investigation for both directions of grain of the material are presented in figures 4 and 5, which show the increase due to forming in compressive yield stress σ_{cy}, tensile yield stress σ_{ty}, and tensile ultimate stress σ_{tu}. In addition, the reduction in elongation resulting from forming is shown in figure 4.

From these results, the following conclusions may be drawn with regard to the effect of brake forming on the material properties of 0.125-inch-thick 24S-T aluminum-alloy sheet that had been formed to an inside bend radius of three times the sheet thickness:

1. Forming appreciably raises both the tensile and the compressive yield stresses. The increase is greatest in the compressive yield stress for the with-grain direction.

2. Forming only slightly raises the ultimate tensile strength.

3. Forming considerably decreases the percent elongation in 2 inches.

4. Forming markedly changes the shape of the tensile and compressive stress-strain curves.

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va., March 21, 1946

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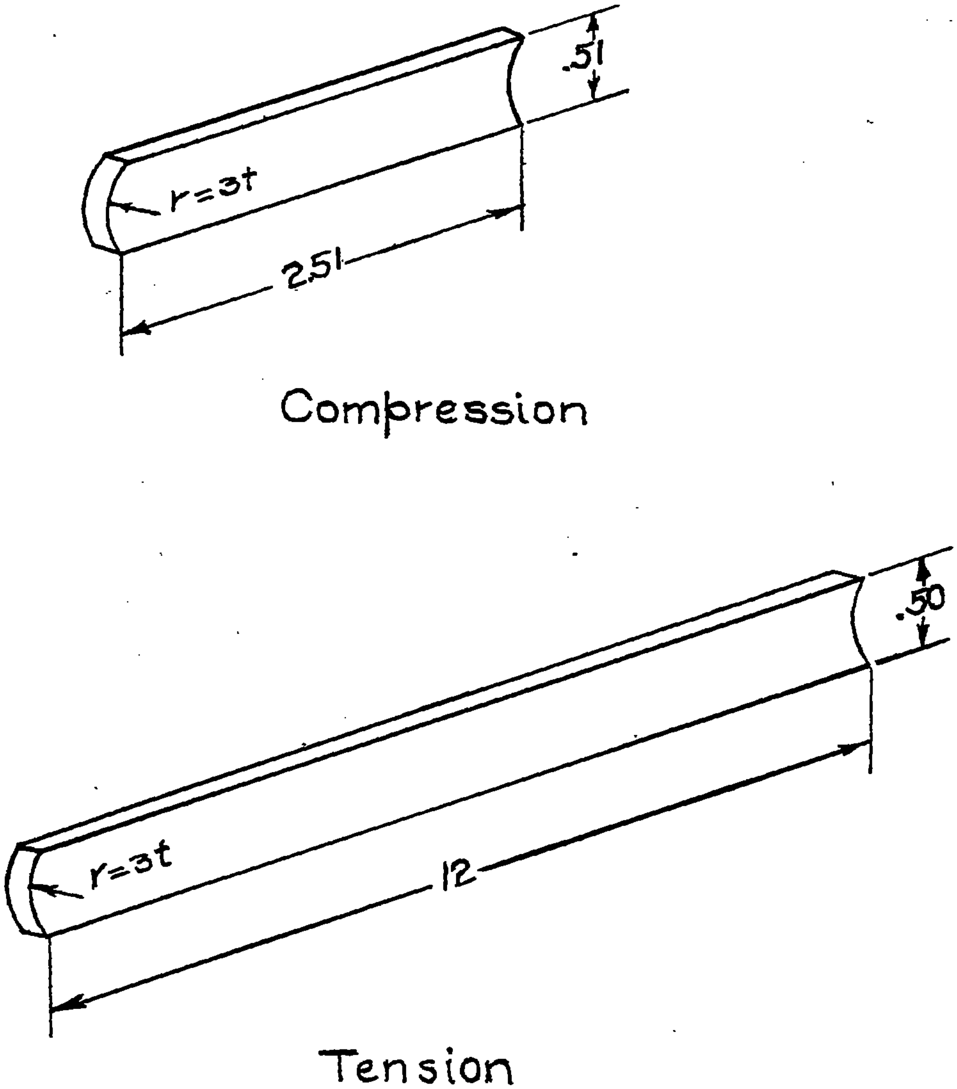

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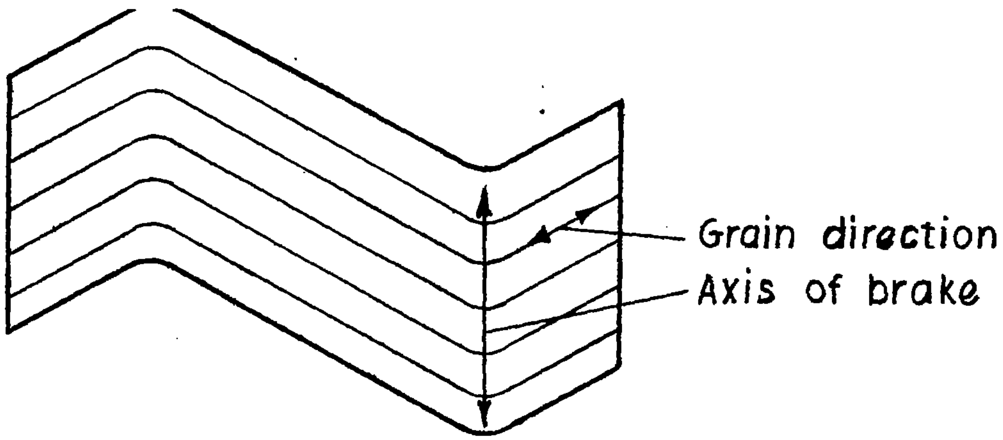
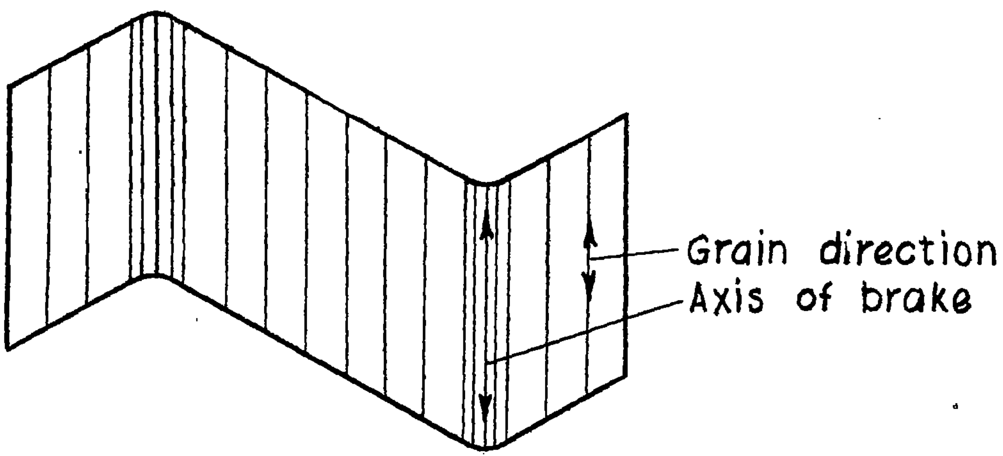
Figure 1.- Dimensions of tension and compression specimens cut from curved corners of formed Z-sections. t=0.125 inch.



(a) Brake cross grain.



(b) Brake with grain.

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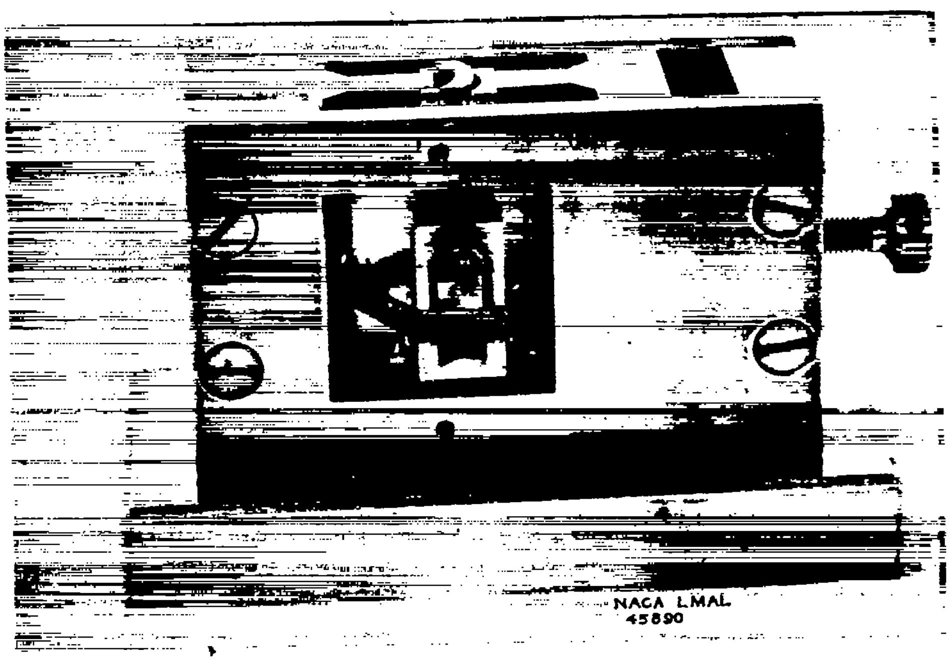
Figure 2.- Directions of forming Z-sections.

(a) Unassembled.



(b) Assembled.

Figure 3.- Montgomery-Templin type of compression fixture with rollers removed, showing supporting plates used for curved corner compression specimens.

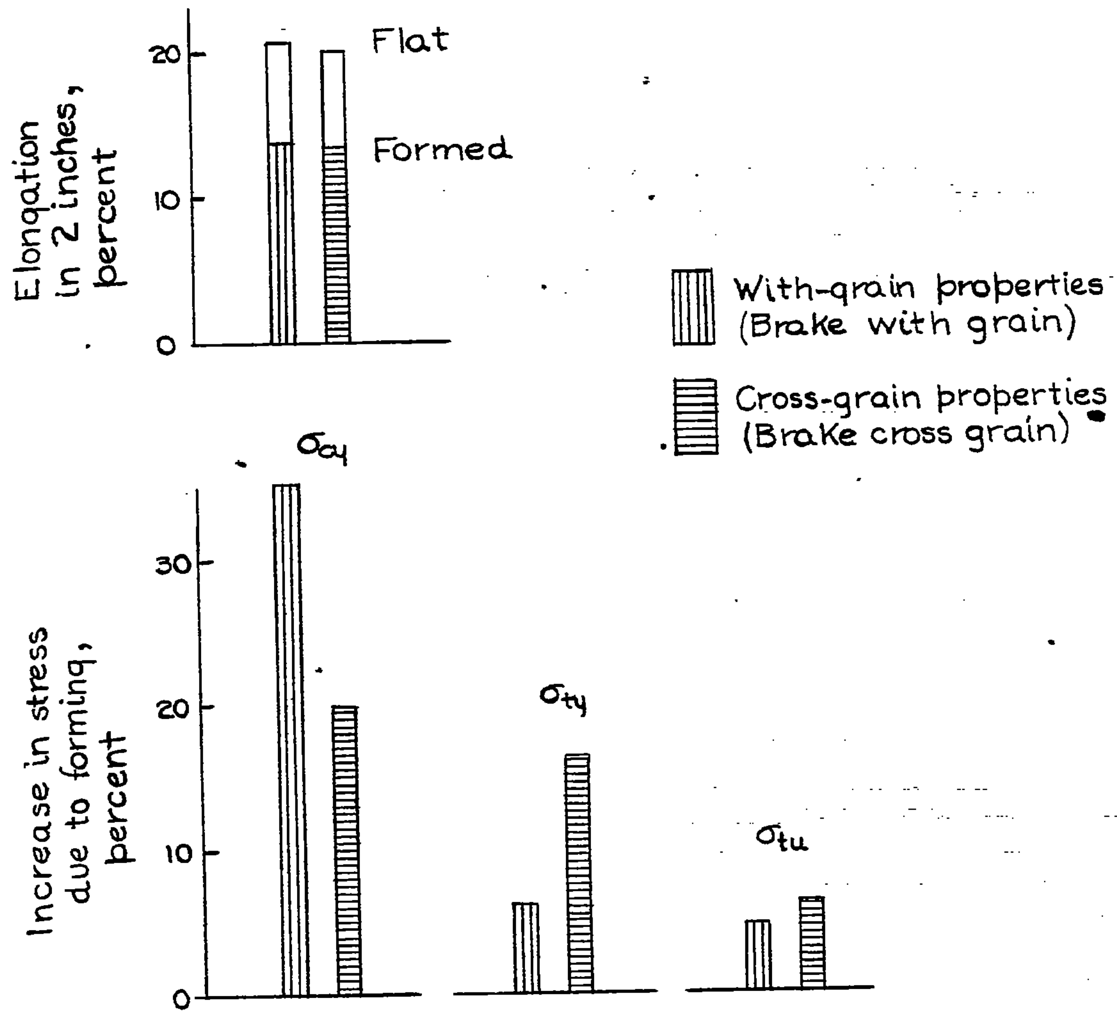


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Figure 4.- Effect of brake forming on the tensile and compressive properties of 0.125-inch-thick 24S-T aluminum-alloy sheet. r = 3t.

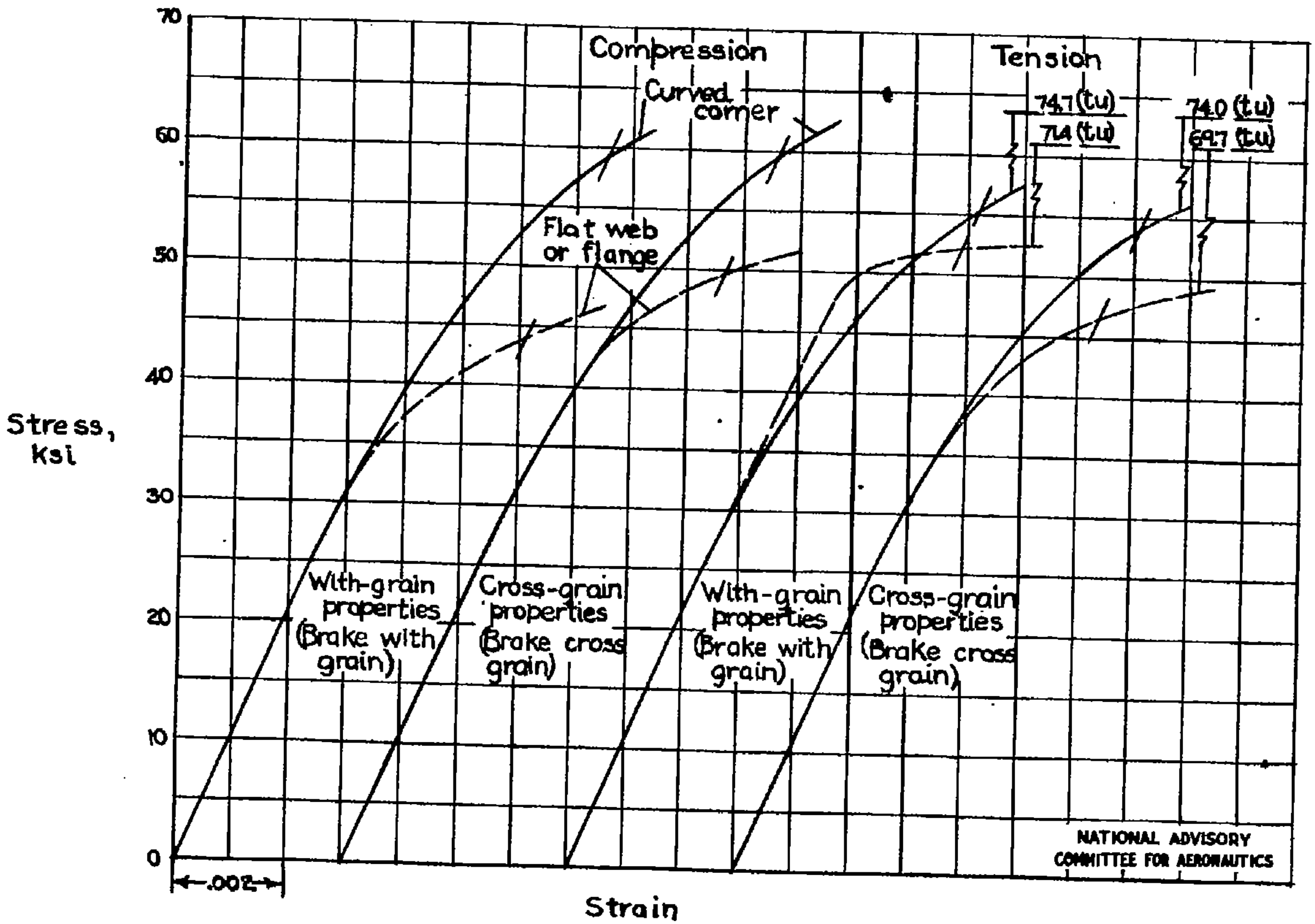

Figure 5.- Effect of brake forming on the compressive and tensile stress-strain curves of 0.125-inch-thick 24S-T aluminum-alloy sheet. r=3t.